Compiler Support for Message Passing Systems
Darpa Contract No. MDA972-97-C-0003

Quarterly R&D Status Report
June 28, 1997 – September 26, 1997

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New Haven, CT

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1. Progress During Reporting Period

In this period, we continued to develop our prototype enhanced MPI tools, focusing particularly on run-time error checking designed to ensure that senders and receivers make the same assumptions about the content of message payloads. As part of this work, we developed error checking functionality not only for our enhanced MPI syntax, but also for standard MPI Pack and Unpack operations used in the context of MPI_Send() and MPI_Recv(). The effort in this period conforms to the approach laid out in our proposal for the core project. The work in this quarter primarily addresses objectives *e.4.1, e.4.2, e.4.3,* and *e.4.5* in our work plan.

In addition to the technical work, we took part in the following activities in relation to the work in this project:

1. On September 17-18, Dr. Sherman attended *HPEC '97: First Annual High Performance Embedded Computing Workshop*, a meeting cosponsored by DARPA and the US Navy, which held at Lincoln Laboratory in Lexington, Massachusetts. At the workshop Dr. Sherman presented a poster session entitled *"A High-Level Interface for Real-Time Message Passing Systems"* based on the work in this project. Dr. Daya Atapattu and Dr. Nicholas Carriero contributed to the preparation of the poster session.

2. Dr. Sherman, Dr. Carriero, Dr. Sachit Malhotra, and Dr. Martin Schultz continued to have discussions with personnel at Lincoln Laboratory in regard to possible contract work in which Scientific Computing Associates, Inc. will investigate the use of MPI for Lincoln Laboratory's signal processing library. If SCIENTIFIC undertakes this effort, we expect that one goal will be to explore ways in which the enhanced MPI tools developed in this project can make the library porting project easier and less prone to errors.

1.1 Enhanced MPI Prototype Development

1.1.1 Run-Time Error Checking

The main focus of our effort in this period has been the development of run-time error checking functionality. The idea is to detect situations in which the sender and receiver disagree as to the interpretation of the contents of a message payload. For example, our prototype will now detect the case in which the sender packs an integer followed by a float into a message, but the receiver unpacks a float followed by an integer.

In order to implement run-time error checking, our run-time system intercepts calls to `MPI_Pack()` and `MPI_Unpack()` so that it can perform internal processing prior to the actual MPI call. For example, on the first call to `MPI_Pack()` for a particular buffer, the run-time system sets up an internal data structure to keep track of the contents of the buffer. On subsequent calls, the internal data structure is modified to reflect the additional packed data. When the buffer is eventually sent using the `MPI_Send()` operation, the system first sends a special "pre-message" that describes the contents of the message buffer. Later, when the receiver uses `MPI_Unpack()` to unpack the received buffer, the run-time system can use the internal data structure it received with the sequence of unpacking operations that occur and can report any apparent errors.

At the present time, our prototype implementation handles only standard MPI basic data types and works only with `MPI_Send()` and `MPI_Recv()`. However, we expect to extend the capability in the near future to handle derived data types and the full range of send and receive variants.

1.1.2 Integration with Standard MPI

As noted in our previous report, it has become increasingly clear that there would be significant added value if we were able to directly parse and process standard MPI in addition to dealing with the "higher level" `_Send()` and `_Recv()` operations. This would make it possible for users to get many of the benefits of our approach on pre-existing MPI programs without making any modifications to them. Eventually, this would enhance our ability to attack the commercial marketplace by reducing a barrier to product acceptance. During this period, we continued to work towards parser enhancements designed to handle standard MPI operations. As a first step in this direction, we were able to implement our run-time error checking for standard MPI send and receive operations as well as for our enhanced operations.

2. Planned Activities and Milestones

We will continue the development of our MPI prototype software, focusing particularly on improvements in the runtime implementation and on better integration with standard MPI.

As noted in our previous report, we continue to have an interaction with the MPI/Real-Time Forum. Our plan is to get more actively involved at such time as the Forum has reached agreement on a draft standard to which we can apply our analysis and error-checking techniques. One particular area in which we may be able to collaborate is in the implementation of admittance testing, where it is important to have some semantic analysis of the demands of a particular program. Much of what we have done in this project is based on just such analysis.

We continue to be interested in arranging for early exercise of the two options associated with the project, since we believe that DARPA would see significant benefits if our work were to be accelerated. Based on discussions with Ms. Connie Jacobs of the DARPA SBIR Office, we plan to raise this issue again with Dr. Jose Munoz, the DARPA program manager for this project, towards the end of the calendar year.

3. Administrative Information

No significant problems have arisen in this period, and there are no areas of concern. The core portion of the project is on schedule with respect to technical development, and the cost is consistent with the expenditure plan. There were no changes in key personnel during this period, and there were no purchases of major equipment in this period.

Personnel Hours		
	Planned	Actual
Current Period	463	462.5
Contract Since Inception	2058	2058

Expenditures in current period: $ 51,428 (inclusive of fee)

Expenditures since inception: $ 227,718 (inclusive of fee)

Total funds committed: $ 374,733

Estimated funds for completion: $ 147,015

Approximate quarterly breakout of anticipated payments from DARPA:

$ 45,000 per calendar quarter through 2Q1998;
$ 60,000 in 3Q1998;
$ 16,211 in 4Q1998.

Estimated date of completion: October 15, 1998